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An Evaluation of the RF LOS/BLOS Communications Enhancements Deployed with USS *BOXER* Amphibious Ready Group

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EXECUTIVE SUMMARY

OBJECTIVE

This report presents the results of one of three operational deployments of products produced by the Expeditionary Warfare Communications Enhancement Project (ExWAR). ExWAR supports the re-structuring of joint command and control by introducing existing commercial and government products into line-of-sight (LOS) and beyond line-of-sight (BLOS), high-frequency (HF) and ultra-high-frequency (UHF) voice radio circuits. The program provides TCP/IP-based data communication linking units of the Amphibious Ready Group (ARG), including the smallest shore-based components of the Marine Expeditionary Unit (MEU). This report discusses the empirical research conducted by the USS *BOXER* ARG.

METHOD

Upon initiation of the project, ExWAR engineers identified products that could extend the utility of existing voice circuits. Project researchers, sponsors, and fleet representatives constructed a set of qualitative evaluation criteria by which the performance of the products would be judged. These criteria were then decomposed into measurable elements and strategies were propounded for data collection. These strategies were incorporated in two sets of tests: (1) the In-port and (pre-deployment) Underway Test, and (2) the Deployment Test. The former test provided a baseline measurement of the "best-case" performance of the products. The Deployment Test, conducted during 6 months of actual operations, represented the users' perception of the products' utility under operational conditions.

The demonstration of candidate products was conducted during a 3-year period. During that time, differing mixes of equipment were installed in three deploying ARGs: *ESSEX* ARG, *BOXER* ARG, AND *NASSAU* ARG. This report presents the results of the Deployment Test of the *BOXER* ARG.

CONCLUSIONS

The entire user community was generally receptive and made use of the products. The empirical data reported herein indicate a high and novel use of the products installed on *BOXER* ARG. Surprisingly, the use of e-mail for "health and comfort" (i.e., to communicate with family members) was exceeded by its use for military purposes. The former use had the entire personnel complement as its potential user base whereas the potential user base of the latter was restricted by limited terminal availability in the workspace. The use of the system for liaison with shore facilities during the periods immediately following deployment and preceding return also surprised researchers. Finally, the system was used for direct communications among the Commanders of the ARG units. It is believed that this was the result of its utility as a private method of interpersonal communication.

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INTRODUCTION

The Expeditionary Warfare Communications Enhancement Project (ExWAR) is an advanced communications research project will facilitate re-structuring joint command and control capabilities. By adapting commercial off-the-shelf (COTS) products that emphasize transmission processing, ExWAR communications facilities link Amphibious Ready Group (ARG) platforms and Marine Expeditionary Unit (MEU) elements without the use of satellites. These radio frequency (RF) communication enhancements also scale to missions as they flow from sea to shore, extending the flow of information to the smallest components of the MEU. This effort delivers significantly improved communications flexibility by installing and evaluating its commercial products according to contemporary prototype development practices.

The program's primary function is to identify, combine, and demonstrate government off-the-shelf (GOTS), nondevelopmental items (NDI), and COTS communications products as a mechanism for exploiting technological advances in the near-term. Its practices are a proven mechanism for injecting successful system candidates directly into the Fleet. The program emphasizes empirical operational research and applies techniques of managing prototype integration in-situ. Besides being a rapid-deployment technique, this Advanced Concept Technology Demonstration (ACTD) is also a valuable and uniquely structured testing vehicle for evaluating the impact of new products and techniques in an operational environment.

This is the third USS *BOXER* report. The report reports the analysis data USS *BOXER* collected during the deployment.demonstration data results collected during the deployment phase. Its treatment of the data collected during deployment is consistent with that of the pre-deployment and mid-deployment tests. Therefore, like the other two reports, the material and format of this report follows the template for comparative analysis set out in the test planning documentation. The results and conclusions map directly to the evaluation criteria set out for the demonstration in FY 96.

BACKGROUND

The first stage of this project was conducted by the USS *ESSEX* ARG on deployment in FY 96. This test evaluated the suitability of applying two technological enhancements to existing RF links:

- A medium-data-rate (MDR) Internet Protocol (IP), line-of-sight (LOS), network exchange system using a wideband 10-MHz code division multiple access (CDMA), 110-kbps, ultra-high-frequency (UHF) suite built around a Hazeltine secure-packet radio.

- Use of an alternative configuration of the above suite to evaluate collaborative planning over an intership desktop video teleconferencing (VTC) system assembled from COTS software and PC hardware.

The second demonstration in the communications enhancement series was performed by *USS BOXER* ARG to evaluate three different extensions of RF technology:

- Exploration of video teleconferencing by testing a MDR VTC capability based on a simplex (broadcast) protocol. This test demonstrated an asymmetrical application of the UHF link with an existing narrowband voice channel as its response link. The broadcast system used an existing AN/WSC-3(V6) radio modified to allow simplex broadcasts of up to 576 kbps among the three amphibious ships. Interaction under the "one-to-many" broadcast modes was supported by a return link using the existing organic narrowband UHF and very-high-frequency (VHF) radio systems on each platform.

- The second demonstration evaluated Joint Military Command Information System (JMCIS) and Tactical Combat Operations System (TCO) data[1] dissemination over a low-data-rate RF Transport Control Protocol/Internet Protocol (TCP/IP) network data exchange system. The Joint Internet Controller (JINC), a technology that simultaneously provides multiple data paths via SINCGARS and HF radios, was installed on the ATG ships and a High Mobility Multipurpose Wheeled Vehicle (HMMWV). Using this vehicle as a mobile “small” shore node, ship-to-ship/ship-to-shore communications were available during deployment.

- In a final demonstration, commercial HF Automatic Link Establishment (ALE) radios provided links to Marine forces ashore while the organic shipboard HF radios provided "ship-to-shore" electronic mail message and file exchange. This demonstration was a first-time application of the Battle Force HF e-mail system to a link servicing a shore node via the ALE system.

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[1] Over-The-Horizon—Gold tracks, overlays, OPNOTEs, and other message text format (MTF) data.

EVALUATION CRITERIA

Demonstration of USS *BOXER* ARG was conducted under the criteria published in the original Demonstration Test Plan[2], updated to reflect the actual testing and operational conditions encountered during deployment. Table 1 shows the measurement items and the tests that were used to address these conditions during deployment testing.

Table 1. Evaluation Criteria Item (ECI) test map[3].

	FUNCTIONAL ECI's		
	Measurement Items		
1	Reliability		
1.1	Measure the Effects of Range	Js; P2; Om	Pg. 17
1.2	Measure the Maximum Rate of File Transfer	I1,2 ; Om	Pg. 13
1.3	Measure the Reliability of Transmission	P1,2; Om	not available
1.4	Accuracy	see Definition	see Definition
1.5	Measure the Symmetry of Messaging	Js; Os	Pg. 20
1.6	Measure the File Transfer Optimization Parameters	Js; Os	Pg. 13
2	Throughput		
2.3	Measure under operational conditions	P1,2; Om	Pg. 13
2.4	Measure under exercise conditions	P1,2; Om	Pg. 13
3	Availability		
3.1	Measure the instance of throughput failure	Js; Om	not available
	OPERATIONAL ECI's		
4	Evaluate the Integrated Data Capability		
4.1	Measure the Application or Use of e-Mail	Os	Pg. 14, 15
4.2	Measure the number of instances of "Reachback"	Os	Pg. 14
4.3	Evaluate the utility of "Reachback"	Os	Pg. 14, 16
4.4	Measure the Volume of Data	Os	Pg. 13, 14 16
4.5	Analyze the Distribution of the Use of ARG e-Mail	Os	Pg. 15
4.6	Were TCO & GCCS integrated ashore?	Om	not available
5	Evaluate the VTC Capability		
5.1	Evaluate the Utility as a CVBG/ARG/MU "Synchronization " Mechanism	Os	Pg. 14, 15, 17
5.2	Evaluate the Usefulness for Collaborative Planning.	Os	Pg. 17
6	Evaluate the System's Use by Special MEU(SOC) Elements		
6.1	Measure use by naval gunfire support assets	Om	not available
6.2	Evaluate utility in Very Shallow Water Mine Countermeasures operations.	Om	not available
7	Evaluate the System's Contribution to Tactics, Techniques & Procedures		
	Procedures (TT&P)		
7.1	Assess Force Mix innovations	Os	Pg. 21
7.2	Assess procedural innovations	Questionnare	n/a
7.3	Assess utility/use in the Rapid Response Planning Process (R2P2).	Interview	Pg. 21
8	Evaluate Collaborative Situation Interpretation	Interview	Pg. 21

[2]Hafner, A. N. 1996. "Test Plans and Procedures for the Expeditionary Warfare Testing of USS *ESSEX* Amphibious Ready Group Communications Upgrade Installations, In-Port Testing." Space and Naval Warfare Systems Center, San Diego, CA.

[3]"Test" applicability codes: P# = Pre-Deployment; I# = In-Port; O = Operational, s = server data, m = Mbx. data. "Results" references the page containing test results that are annotated with the pertinent ECI number in [brackets].

ANALYSIS

This section discusses the method of reduction used to prepare the data for analysis. Operational constraints precluded a pre-planned series of tests, so empirical data from live operations are the basis of this report. The principal mechanisms for data capture were the mailbox function of the applications and the Simple Mail Transport Protocol (SMTP) server logs created by the JNOS operating system. These data were retrieved from each platform at the end of the deployment and were reduced as described below.

DATA REDUCTION

No special provision was made for unique data probes or analytical programs, so the tools for data translation and reduction were available commercial products. This is not unusual in ad-hoc demonstration of COTS prototypes since resource minimization is an essential element in this emerging DoD development paradigm.

Preparation of “*.mbx” Files

The preparation of all client mailbox files of interest was standardized to the intended use of the data. The message type analyzed (e.g., outgoing or incoming) was identified and all other messages (e.g., return receipts) were deleted from the file. Algorithms were prepared to strip formatting characters and the stripped files were then re-formatted as individual records. These records were grouped chronologically as text files and edited for consistency before applying descriptive and inferential analysis algorithms. Generally speaking, the fields[4] of interest were the timestamps applied at each transmission interface: Sending Client (Ta), Sending Server[5] (Tb), Receiving Server (Tc), and the Receiving Client (Td).

Preparation of Server Files

The JNOS server log files are composed of sequential time-stamped entries for each server transaction. The principle fields available were the IP number of the server, a locally assigned job code, and the addresses of the message originators and recipients in standard URL format. Interspersed among these entries were records of the access privileges granted to each local client. These latter records composed over 60% of the file content and provided no information useful to the instant analysis. These data were deleted and the remainder were grouped and saved in files representing 24-hour periods.

Data reduction was accomplished by stripping formatting code and inserting a line feed between each log entry. The resulting data block was an array of linear records, each representing a single message transaction. These arrays were parsed to differentiate attributes for time (TIME), message sender (FROM), message recipient (TO), and job number (JOB_NUMBER). Daily files were assem-

[4]See the next section and figure 3 for a discussion of the treatment of these fields.
[5] For analytical purposes, DNS servers were considered a part of the "black box" described below.

bled into monthly folders and then grouped into eight general categories according to their URLs (table 2). The number of message entries in each of these categories was tabulated and is the basis for the interpretations of the data made in this report.

Table 2. URL entry message group.

Group	URL
CONUS-based military	Non-ARG addresses ending in ".mil"
CONUS internet	Addresses ending in other then ".mil"
FORT FISHER navy	Navy units/personnel addresses at "….fort-fisher.Navy.mil"
OGDEN navy	Navy units/personnel addresses at "….boxer.Navy.mil"
BOXER navy	Navy units/personnel addresses at "….ogden.Navy.mil"
FORT FISHER marines	All Marine units/personnel addresses at "…fort-fisher.Navy.mil"
OGDEN marines	Marine units/personnel addresses at "…fort-fisher.Navy.mil"
BOXER marines	Marine units/personnel addresses at "…fort-fisher.Navy.mil"
FORT FISHER C.O.	Commanding Officer
OGDEN C.O.	Commanding Officer

INTERPRETATION

The data were interpreted within the constraints of empirical measurement and the context of the objectives of the demonstration. The data, being a record of the application of the various telecommunications enhancement products, are a measure of the operational utility of those products. The final report will examine this utility by comparing these results to those of the baseline created from the results of the pre-deployment testing.

Data Model

The model that underlies these analyses depends on an interpretation of the message flow between the ships as a "black box" representation of the Battle Area Network (BAN). Using this interpretation, we acknowledge the complexity of mobile networks operating over unguided transmission media. As noted by Miller[6],

> *"Performance Analysis of today's computer networks is not a trivial task. The unpredictability … is caused by the decentralization trends in the information technology…. Traditional tools for planning and designing networks are too limiting and unreliable. Pencil-and-paper solutions cannot take into account the complex interaction of variables Past experience does not apply to using new technologies. And physical lab tests are often too expensive and are not scaleable."*

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[6]Miller, Mark A. 1995. *Internetworking*. M &T Books, New York, NY.

As shown in figure 1, all of the circuit elements effecting system performance on the transmission side of the sending and receiving JNOS (i.e., SMTP) servers are modeled as a single entity, the "RF link," the subcomponents of which (i.e., radios, routers, antennas, domain name servers, etc.) are not investigated. This strategy for normalizing the data from all of the communications upgrade experiments permits comparison of empirical results from message exchanges in terms of the operational utility represented by the ExWAR ECIs.

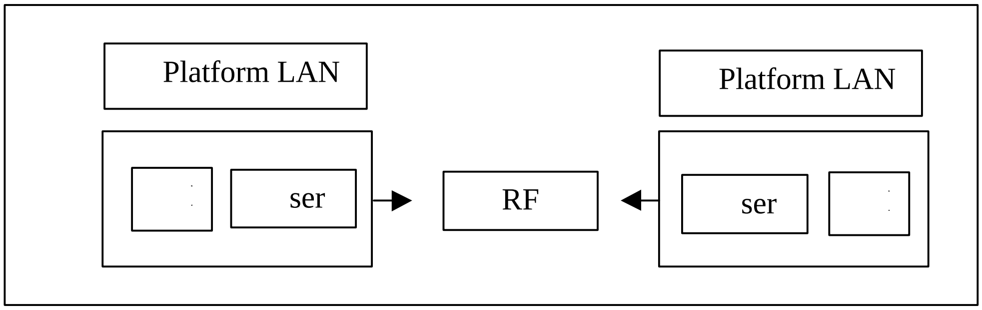


Figure 1. Black box network view.

Figure 2 shows that mMessage handling was evaluated as a sequence of exchanges between a sending client and server pair and a receiving server and client pair.

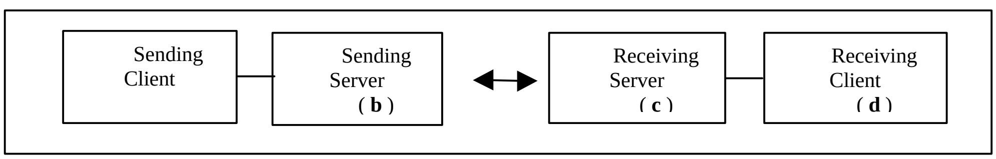
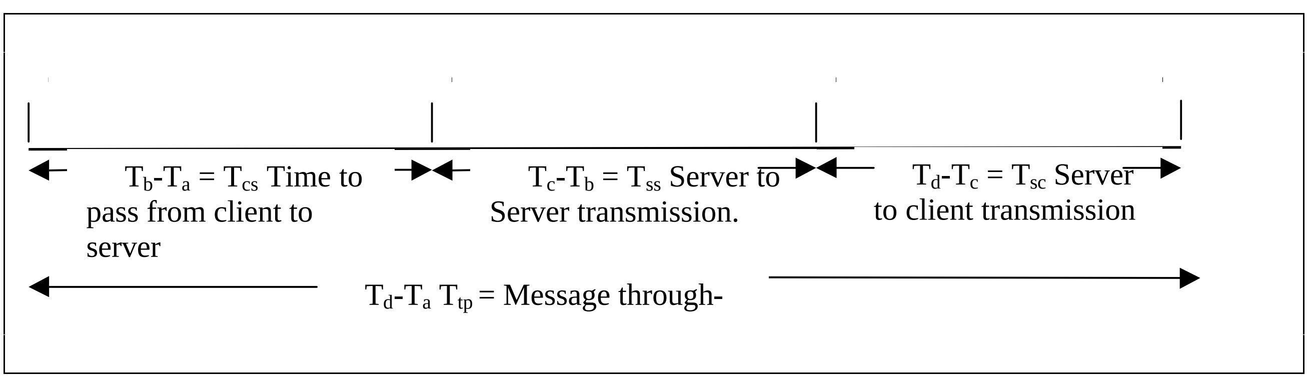


Figure 2. Client-server pairs.

Four measures of the utility of message-handling were calculated on the basis of the time stamps affixed to a sample set of N messages. Figure 3 illustrates this treatment. The measures and their application to the evaluation parameters are defined in the following section.



Ta = Sending client time stamp Tb = Sending server time stamp
Tc = Receiving server time stamp Td = Receiving client time stamp

Figure 3. Message flow timeline.

Evaluation Parameters

The examination of the operational data evaluated the utility of the demonstration system using the logical comparison of the timestamps of the messages, network utilization parameters, performance measurement, and message distribution analysis. The parameters used to perform these evaluations are defined in the following paragraphs.

Circuit Availability. The time to transmit messages from server to server ($T_{ss} = T_c$-Tb) is a measure of the availability of the circuit. Inasmuch as the TCP protocol requires a positive acknowledgement of the correct receipt of each packet at the transmission layer, the successful delivery of a message implies the existence of a circuit of acceptable quality for a specific time period. The differential in the time stamps of sending and receiving servers is a measure of the amount of time required to effect adequate interplatform connectivity. Accordingly, given similar-size messages, the larger the differential, the longer the period of unavailability.

LAN Availability. The difference in the time stamps of the sending client (Ta) and the sending server (Tb) is a weak comparative measure of the availability of the platform LAN (Tcs). Since the in-port tests were conducted as stand-alone tests, there was no competing traffic on the LANs, so the Tcs transfer during those tests was instantaneous. The relative availability of the LAN during deployment can be established by comparing Tcs with that of the in-port tests.

Network Utilization. The network utilization measures employ a broad application of standard waiting line analysis. We stipulate that the system is a single-queue, single-server model with an arrival rate represented by a Poisson distribution. We also assume that the average message is 3k bytes and is packaged in frames of 1500 bytes. Pending further study, we consider a modest network operating rate of 1200 bps with 51 bytes of addressing overhead per frame[7]. Accordingly, the network characteristics are as follows:

- Utilization of the System (P). $P = \lambda / \mu$, where the Mean Arrival Rate (λ) is the value of the number of frames entering the RF link per unit time and the Mean Service Rate (μ) is the reciprocal of the time required to transmit one frame.

- Mean Waiting Time in the Queue. (Wq). $Wq = \lambda / \mu (\mu - \lambda)$

Reliability. Reliability is the success rate with which all transmitted messages reached the addressees.

Accuracy. The TCP/IP protocol provides extensive error-checking facilities. It requires point-to-point communications in which a positive acknowledgement is made for the correct receipt of each data packet. If more than 20% of the packets are found to be in error, the connection is terminated. Thus, the successful transmission of a message implies that its contents are fully authenticated. Accordingly, these tests treat the accuracy of the system as the mirror of its reliability.

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[7]The LAN frame rate for Ethernet LANs is equal to the size of the data frame (here estimated at 1500 bytes) plus 26 bytes overhead per frame. Approximately 25 bytes would be added when repackaging each frame to include WAN header and trailer, resulting in a frame size of 1551 bytes/frame.

Mean Service Time. The average amount of time required for a client device to empty its queue of messages.

Throughput. The throughput of the system is defined as the number of messages exchanged end-to-end per unit time. The time for a single message to go from client to client, calculated as the differential between the time stamps affixed by these two PCs (Ta and Td), represents the throughput time (Ttp) of the message. Therefore, the throughput for a number of messages (N) is the average differential in the time of transmission and time of receipt of those messages. Throughput = Σ Td_n-$Ta_{(n)}$ / N; n = 1 to N.

RESULTS

This section provides testing results as they relate to the criteria assigned in table 1. For the reader‘s convenience, the applicable ECI number (in brackets) follows each result.

PARAMETRIC ANALYSIS

This section presents calculation results of the inferential network parameters.

Throughput

Messages were generally delivered to the receiving client in 18 hours, 37 minutes. The greatest elapsed time to delivery was 32 hours. Nnote that undelivered messages expire in 72 hours and the timing of mail downloads from the local server is a variable set by the client. [1.2]

Circuit Availability

Whenever messages were available for transmission, the average time required to effect a connection between platform servers was 14 hours, 25 minutes. [2.3]

Network Utilization

The network response to the message traffic to and from the *OGDEN* and *FORT FISHER* during the July period of high activity was reviewed. During this time, the network operated at 2% of its capacity and, excluding the time to establish a link, messages spent 0.19 seconds in the server queue awaiting transmission. [1.6]

Mean Service Time

The amount of time taken for the *BOXER* client to empty 94 messages was 4 minutes, 13 seconds (0.04:13). [2.4]

TRAFFIC ANALYSIS

This section presents the calculation results of network behavior descriptive data models.

Outgoing Traffic

Table 3 shows that:

1. During deployment, two small ships sent a total of 5394 messages. [4.4]

2. This total represents approximately 28 messages per day. [4.4]

3. 16% of the messages sent (843/5394 were “Heath and Comfort” messages (i.e., those sent to “CONUS Internet” addresses). [4.2, 4.3]

where:

- Civilian Internet: All messages sent or received from addresses ending in a domain other than ".mil".

- All Military: All other messages remaining after the Civilian Internet messages were removed.

- CONUS-Based Military: Messages specifically addressed to domains not included in the ARG domain set.

4. 84% of all messages transmitted by the demonstration link had military applications. [4.1]

5. Military recipients in CONUS were the addressees in 275 outgoing military messages. Thus, the outgoing "reachback" was 6% of all messages sent. [4.2, 4.3, 5.3]

Table 3. Combined *OGDEN-FISHER* outgoing message traffic use.

Use	March	April	May	June	July	August	Sept	Total
Civilian Internet	37	225	188	131	167	81	14	843
All Military Clients	286	507	356	784	1110	832	676	4551
CONUS-Based Military	170	46	18	8	9	0	24	275
Total	323	732	544	915	1277	913	690	5394

Incoming Traffic

Table 4 presents the distribution of the operational messages received by either Navy or Marine users aboard each platform. The non-operational messages received from sources on the Internet were stripped out of these statistics and are reported as a separate category. Table 4 shows that:

1. The total number of messages received by the two small ships during the deployment was 8089 messages. [4.4]

2. This total represents approximately 42 messages per day. [4.4]

3. “Heath and Comfort” messages (CONUS Internet) were 37% (3012/8089) of the incoming traffic load. [4.2, 4.3]

4. The Marines received 1049 incoming messages from military sources. Therefore, 21% of incoming military messages were related to Marine functions. [4.1, 5.1]

5. Naval users received 4028 of the incoming military messages. Therefore, 79% of the messages from military sources that were received by the small ships were related to Navy applications. [4.1, 5.1]

Table 4. Incoming message traffic user comparison by ship.

	March	April	May	June	July	August	Sept	Total
OGDEN								
Internet	51	254	270	677	739	521	419	2931
Navy	219	496	304	680	847	750	613	3909
Marines	3	84	51	223	315	245	89	1010
							Sub-total	7850
FORT FISHER								
Internet	0	0	0	1	75	5	0	81
Navy	85	1	18	1	3	4	7	119
Marines	28	0	4	4	3	0	0	39
							Sub-total	239
							Total	8089

DISTRIBUTION ANALYSIS

This section evaluates the utility of the system by scrutinizing message capability usage. Outgoing message traffic is analyzed as an aid to the interpretation of user-driven employment (see, for example, the use by Commanding Officers). Subsequent to that, incoming distributions are observed to evaluate the utility of the demonstration system from the perspective of non-organic entities.

Outgoing Applications

Health and Comfort versus Military Use. Figure 5 contrasts use of the new demonstration channel to send military messages in relation to its use for Health and Comfort in communication with civilian addresses. The figure shows the use of the civilian Internet peaking early in the deployment and then declining. Conversely, military uses steadily increased, achieving and sustaining a high-use pattern by the Summer. [4.5]

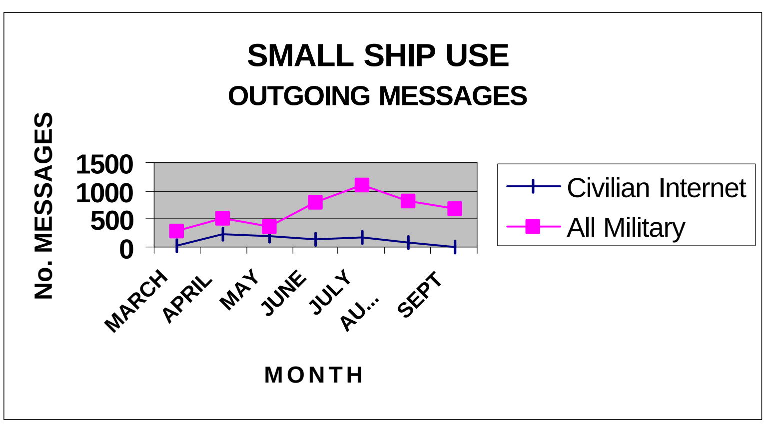

Figure 4. Small ship use.

Reachback. Figure 5 shows the transmission of information to CONUS. These data show that civilian Internet messages rapidly rose to a peak and declined over the deployment[8]. This suggests a rapid user learning curve motivated by personal interest. Alternatively, reachback to CONUS military facilities dropped soon after deployment and appear to have been rising again at its end. This suggests the use of the channel for making logistic arrangements with various CONUS facilities concerning departure and arrival. [4.3]

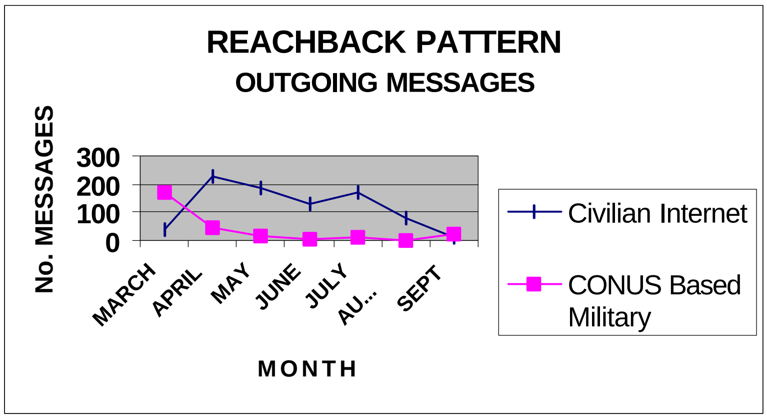

Figure 5. Civilian versus military reachback pattern.

Detailed Employment by Using Entity. Figure 6 shows the period of high outgoing message activity during July suggested by figure 4. Message transmissions by all users of the Navy and Marine components aboard *OGDEN* were grouped and differentiated. These data show a period of high Naval message activity beginning 15 July and sustaining through the month. Alternatively, Marine message transmissions did not become significant until 30 July. [4.4]

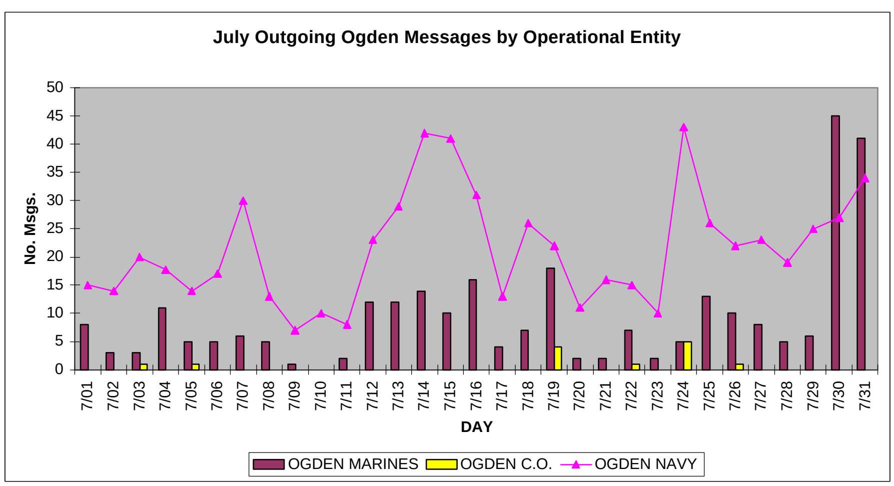

Figure 6. USS *OGDEN* outgoing operational messages in July 1997.

[8]Note: Differences in scale between figures 4 and 5 obscures the small dip in the June civilian Internet.

Plots of the ARG platform locations were made based on record data obtained from the Position Location and Reporting System (PLRS)[9]. Figure 7 shows the locations of the ARG platforms on 15 July.

Range of Effectiveness. The maximum effective range was not determined. However, figure 7 shows that the ARG ships were operating jointly and at distances of at least 25 nautical miles during the period of highest use. [1.1]

Figure 8 shows USS *OGDEN* proximate to the coastline of the United Arab Emirates on 30 July 1997. Absent an operations log, it seems reasonable to infer that the outgoing message distribution pattern matches the operational tempo of the venue of the respective user entities. Accordingly, high use of the circuit by Naval components from mid-month on, and the spike in Marine message traffic in the littoral at the end of the month indicates a successful landing operation. [5.1]

It is also interesting to note that in figure 6 the OGDEN Commanding Officer's use of the circuit to send message traffic during the middle of the above operation. [5.2]

Incoming Applications

The distribution of incoming messages was examined on the reasonable expectation that it would be useful to examine "push" to the small ships of the ARG. To this end the pattern of the incoming messages is compared between platforms, the combined incoming "Reachback" of the two ships was plotted, and the user entity distribution of each ship was examined. This section presents and discusses these data.

Comparative Distribution. Figure 9 compares the incoming message profiles of both ships for the entire deployment. It should be noted that dual "y" axis are used because the quantity of messages received by OGDEN far exceeds that of *FORT FISHER*. Not surprisingly, the *OGDEN* distribution matches that presented in figure 4. The history of incoming messages for *FORT FISHER* shows high initial success droping to zero and erratic performance except for the July activity period. This suggests that there was disinclination on the part of *FORT FISHER* personnel to devote the necessary resources to maintain the circuit.

[9] PLRS data, analysis services and plotting were done by Mr. Robert Lara, SAIC, San Diego, CA.

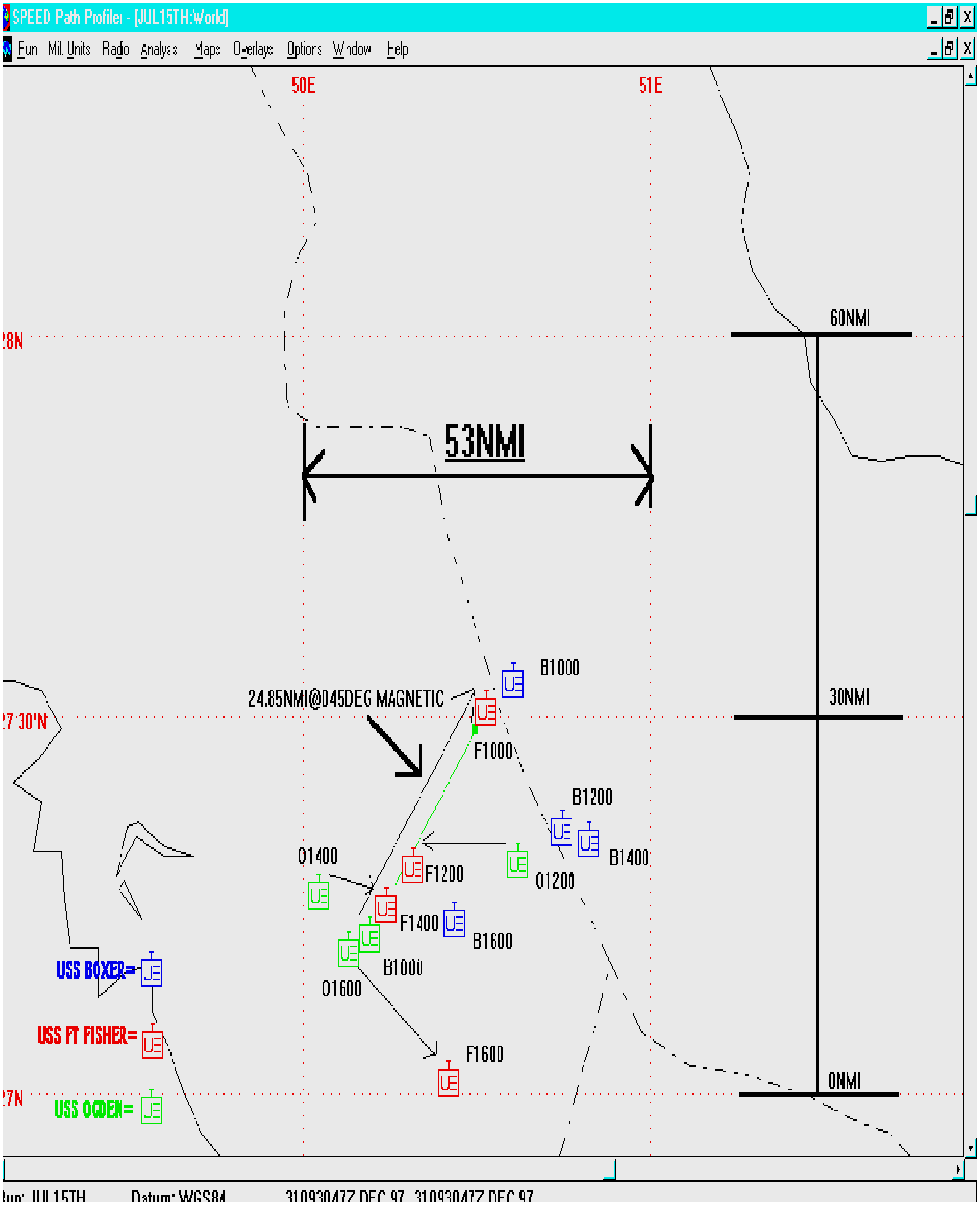

Figure 7. ARG locations, 15 July 1997.

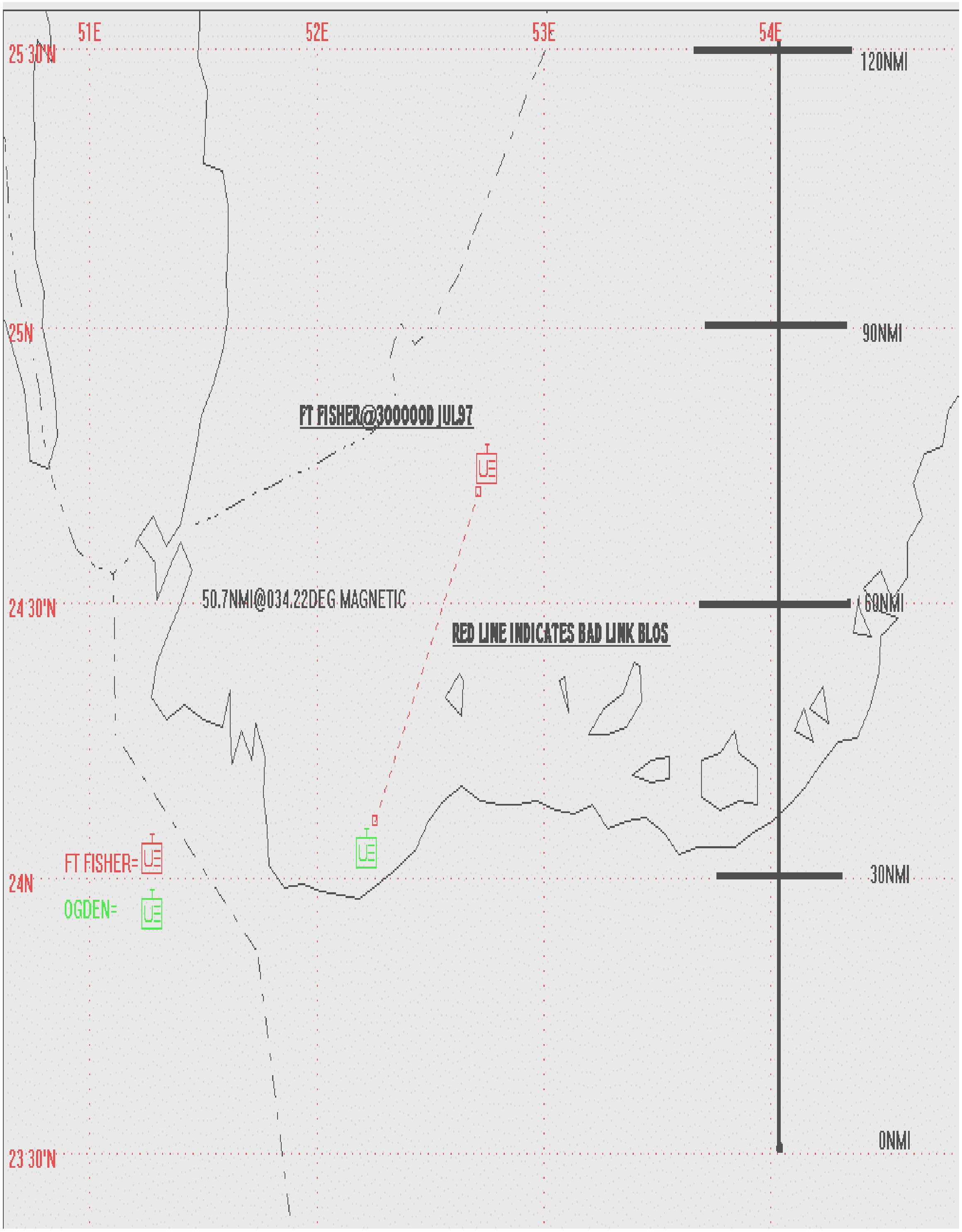

Figure 8. ARG locations, 30 July 1997.

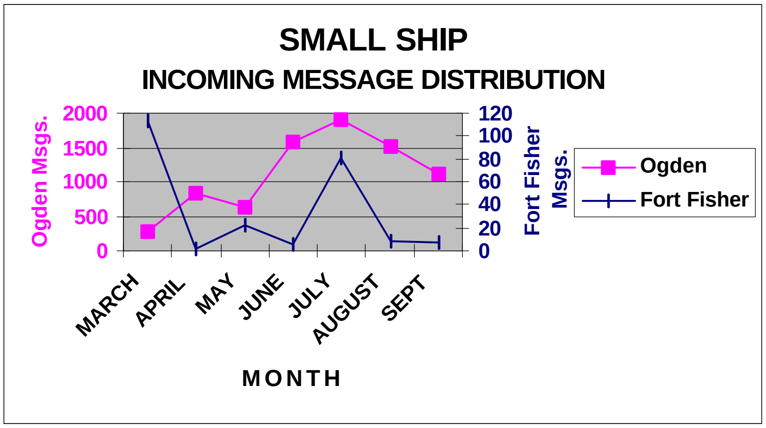

Figure 9. Small ship message distribution.

Reachback. The reachback distribution presented in figure 10 shows that the incoming, or the "response," message traffic from the CONUS Internet is almost a mirror image of its outgoing distribution. [1.5]

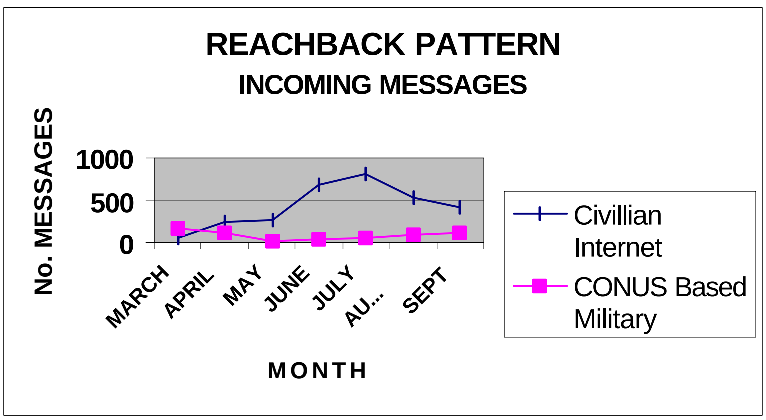

Figure 10. Civilian versus military reachback pattern.

User Entity Distribution. Figures 11 and 12 show the monthly pattern of the incoming messages for *FORT FISHER* and *OGDEN*, respectively. These data suggest that *FORT FISHER* was initially successful in its application of the demonstration system interest flagged while the capability (see July Internet) still existed.

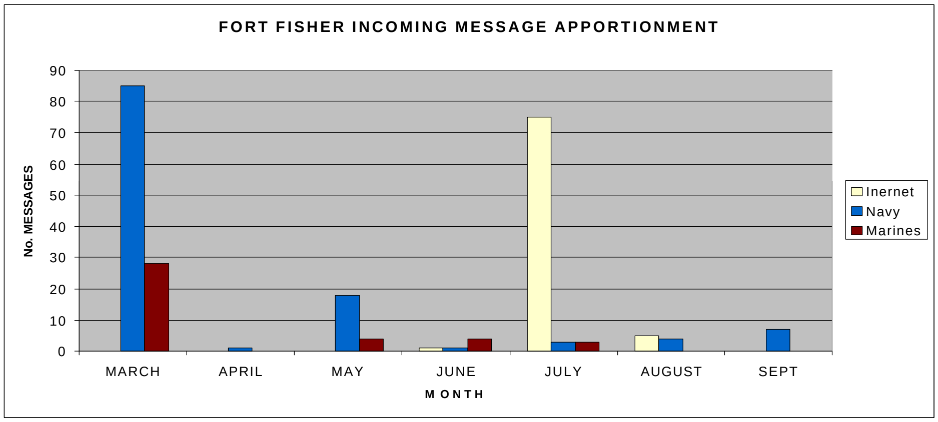

Figure 11. USS *FORT FISHER* incoming messsage apportionment.

The distribution of *OGDEN* messages in figure 12 suggests a robust application of the demonstration technology and, surprisingly, a preponderance of Naval applications on this, the Logistics platform of the MEU. [7.1]

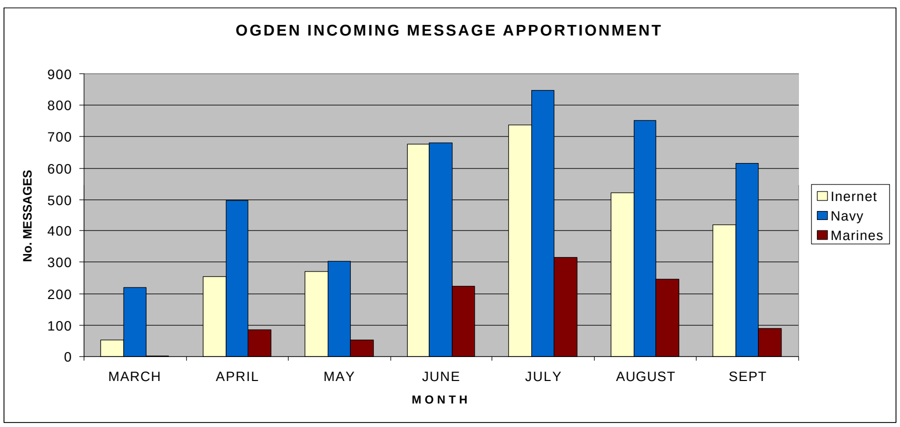

Figure 12. USS *OGDEN* incoming message apportionment.

INTERVIEW

The debrief of personnel who used the VTC capability disclosed that the asymmetrical capability provided was undesirable because it made no provision for showing briefing respondents. [7.3, 8]

DELIMITATIONS

As with all field testing, certain limitations in the demonstration potentially restrict the interpretation of its data. The battery of deployment tests was not implemented and the recovery of operational data was limited to non-Marine systems. The former shortcoming was occasioned by less than dynamic advocacy on the part of the Afloat Test Coordinator. The latter occurred because the Marines pre-packaged and debarked all of their equipment before the ships returned to San Diego.

Inconsistent message labeling caused by differing optional client settings, the purging of critical data files by several Divisions, and the lack of accurate interplatform timing reduced the accuracy and applicability of these tests. Nevertheless, notwithstanding some certain error, it is believed that the tendencies and gross magnitudes of the calculations are reliable and support the general inferences of performance and acceptability.

CONCLUSIONS AND RECOMMENDATIONS

This section offers the conclusions and recommendations of the investigators based upon their interpretation of the data and the circumstances of the demonstration as mitigated by the limitations discussed above.

FUNCTIONALITY

13,483 messages were exchanged in an average delivery time of less than 19 hours at ranges up to 25 miles. Absent the RF system enhancements, the information contained in these messages would either not have been exchanged or would have impacted the more traditional transmission resources of the ARG. Of these messages, 71% applied to military activity with naval functions aboard the two amphibious support platforms making equal or greater use of the facility than the landing force functions. Of particular interest is the observation that the Commanding Officers of the two ships personally used the terminals at their disposal to exchange information. Operational throughput during the high-usage July amphibious exercise required only 2% of intra-ARG network capacity.

OPERATIONAL PERFORMANCE

The ships of the ARG exchanged over 5000 operational messages during the deployment and averaged 39 requests per month for information from shore-based military sources. During amphibious operations, the use of the system for operational coordination among naval functions was apparent during the approach to the objective whereas landing force coordination peaked during the move ashore. Synchronization and "Collaborative Planning" were effected through the system e-mail facility by both ships personnel and ARG staff organizations including the commanders of the ARG ships. The use of the system for coordination of naval functions exceeded use by the embarked Marine organizations, leading the researchers to believe that the system upgrades should be permanently installed rather than accruing only to landing-force embarkation.

Video Teleconferencing

The application of video teleconferencing over high-bandwidth UHF LOS connectivity was technically successful but the asymmetrical links employed in this demonstration only allowed the briefer and his materials to be visible. This was surprisingly undesirable to the users and did not receive user support. The technical success of the enhanced radio capability was exploited in a revised scheme that provides duplex face-to-face sessions for the TARAWA ARG. In an adaptation of the transmission technique and prototype equipment discussed in this report, a full-duplex, point-to-point link between the LHA to each of the other ships in the ARG was installed on TARAWA. A VTC bridge was also employed to allow multi-user collaborative planning sessions and conferencing between the ARG ships. This duplex VTC capability has received high user praise.

Shore Node Beyond Line of Sight

The performance of this set of communications enhancements achieved and demonstrated considerable user support and proved the viability of the links throughout the sea-borne operations. Notwithstanding, it was hoped that the included "Small Shore Node" and its ALE-capable

HF radio system would also prove its credibility when used in beyond-line-of-site (BLOS) links to deployed mobile Marine forces. Unfortunately, the unit was reserved to the highest landing force echelon. Since no operational mandate for debarkation of this echelon presented itself during the deployment, the shore node was not disembarked, and the capability went untested.

Training

Throughout each demonstration, the performance of the more complicated devices appears to have been effected by insufficient user training. The initialization and continued operation of these systems was generally beyond the threshold of training of the radiomen, both Sailor and Marine. This experience can provide a valuable lesson for those who envision the seamless introduction of commercially successful COTS systems. The project staff is experimenting with an interactive, remote-intervention tool for assisting operators to operate prototype devices and software in the future.

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The Expeditionary Warfare Communications Enhancement Project (ExWAR) identifies, combines, and demonstrates Government off-the-shelf (GOTS), nondevelopmental items (NDI) and commercial off-the-shelf communications products as a mechanism for exploiting technological advances in the near-term. This report provides data results collected during the deployment demonstration of USS *BOXER* ARG. Its treatment of the testing done by *BOXER* during deployment is consistent with that of the predeployment and mid-deployment tests. The results and conclusions map directly to the evaluation criteria set out for the demonstration in FY 96.

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